

SPECTX



Offshore Windmills
Autonomous Aerial Inspections

Problems



Manual inspection

Wind turbine inspection done manually is expensive, high-risk and time consuming and cannot detect internal structural defects fast & effectively.



Visual inspection

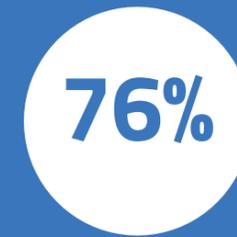
Alternative drone visual inspection can only detect a limited number of external defects. However, some of the structural defects are not visually detectable externally.



Internal defects

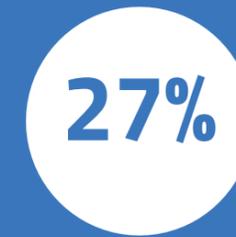
3800 blades fail a year due to internal defects causing longer downtimes and high replacement costs.

Percent of turbines with unexpected damage



category 3

\$1.5 B to repair



category 4

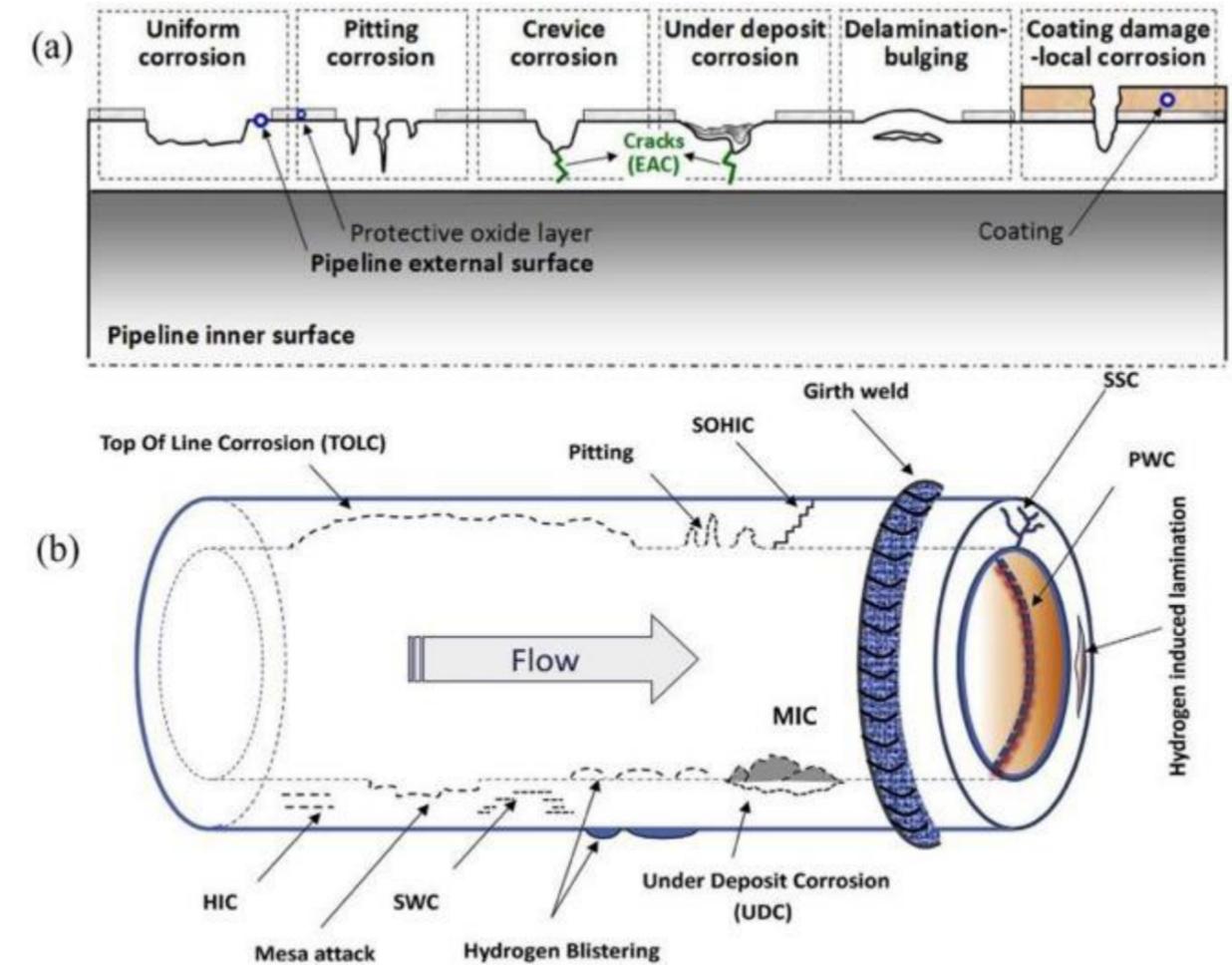
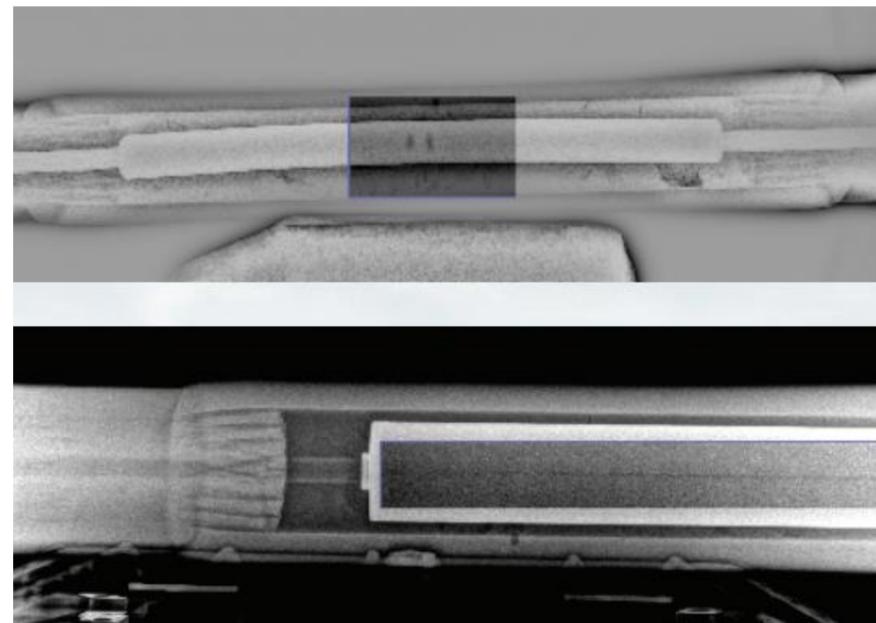
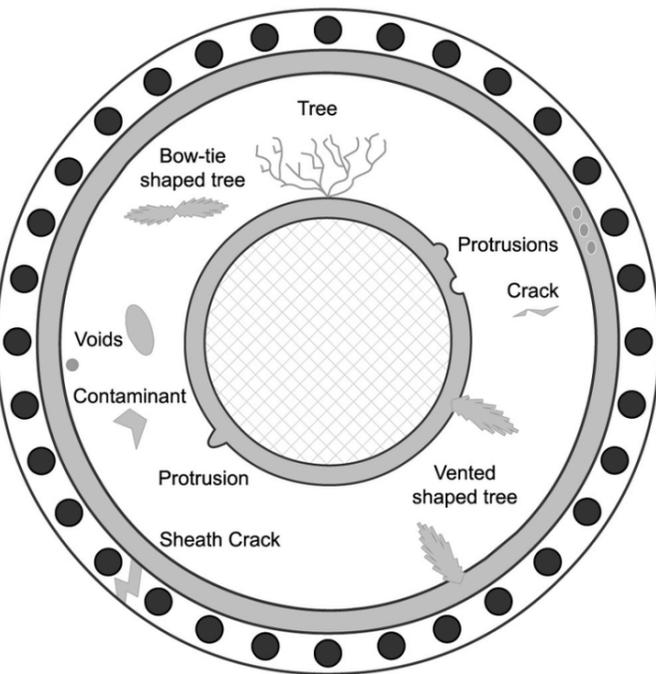
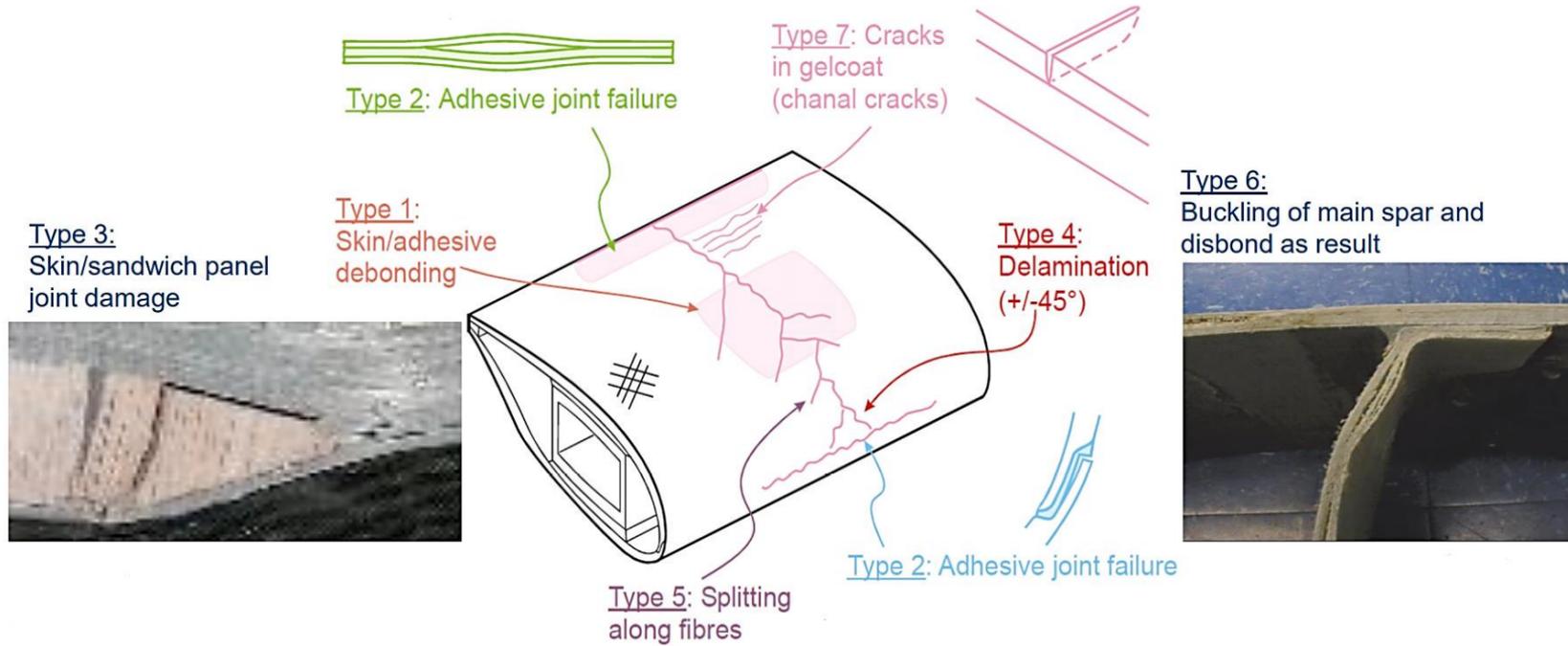
\$2.1 B to repair

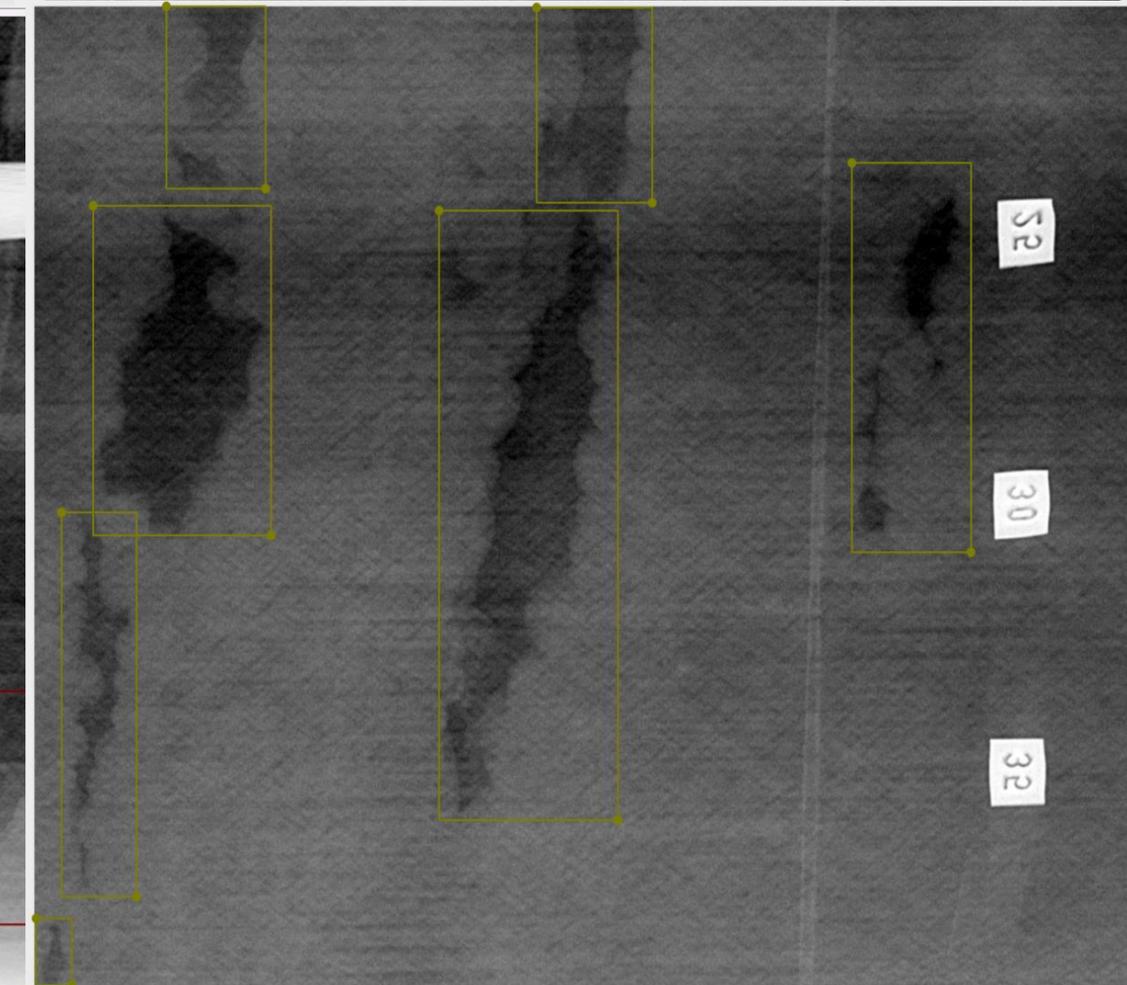
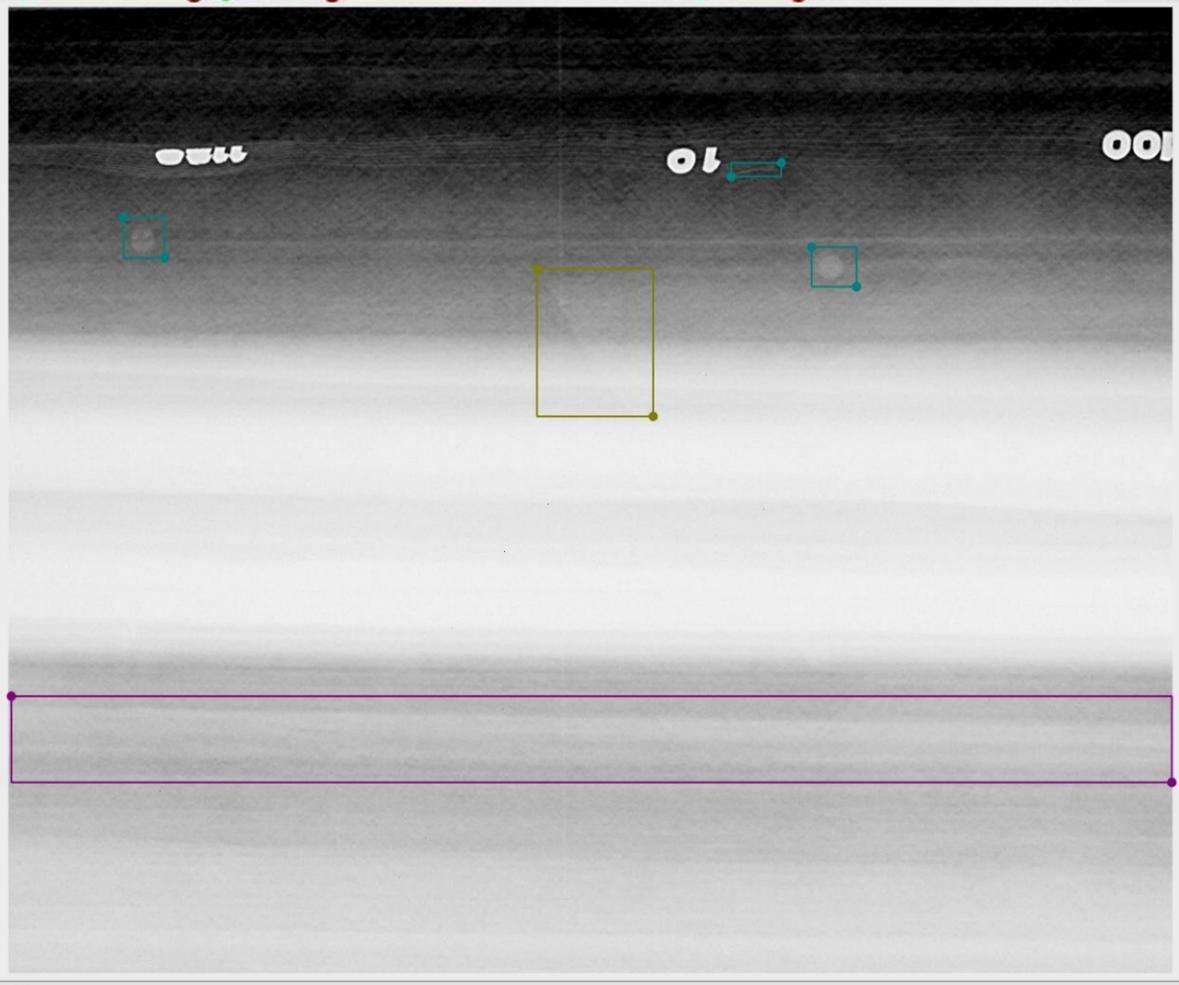
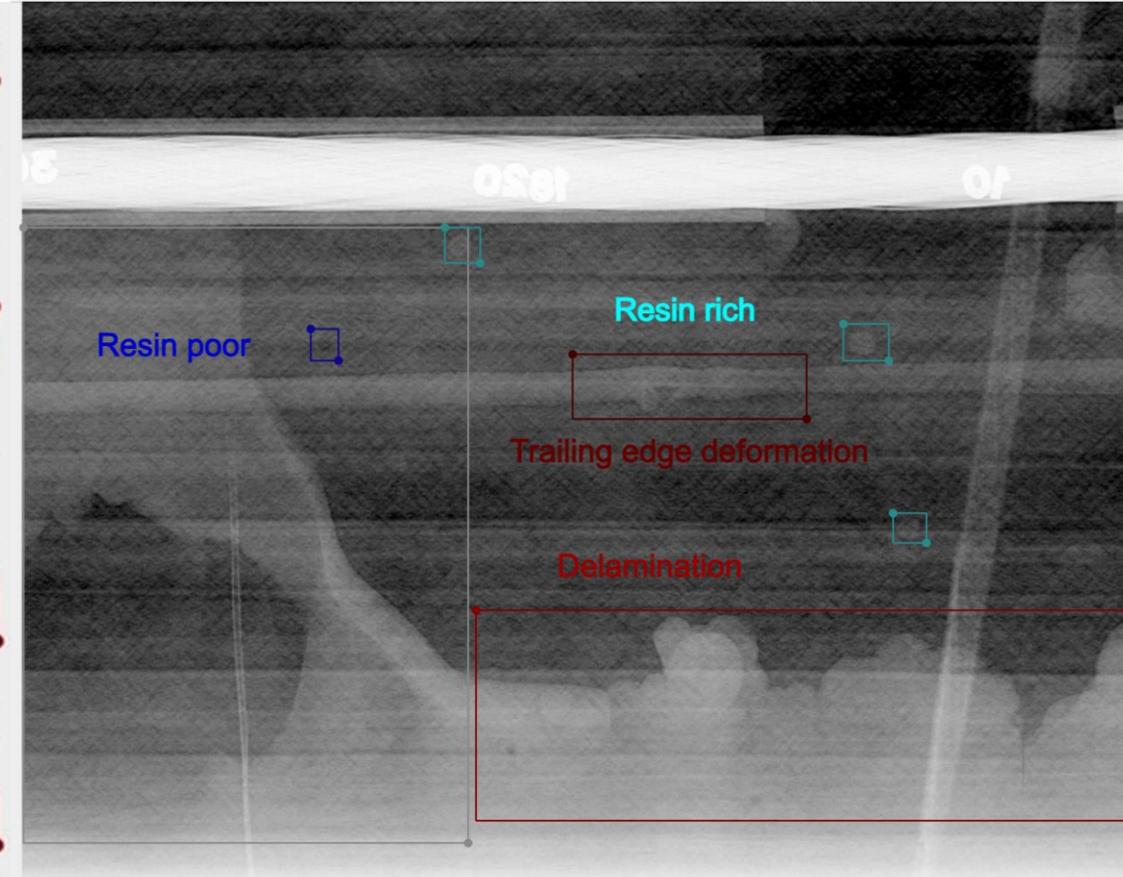
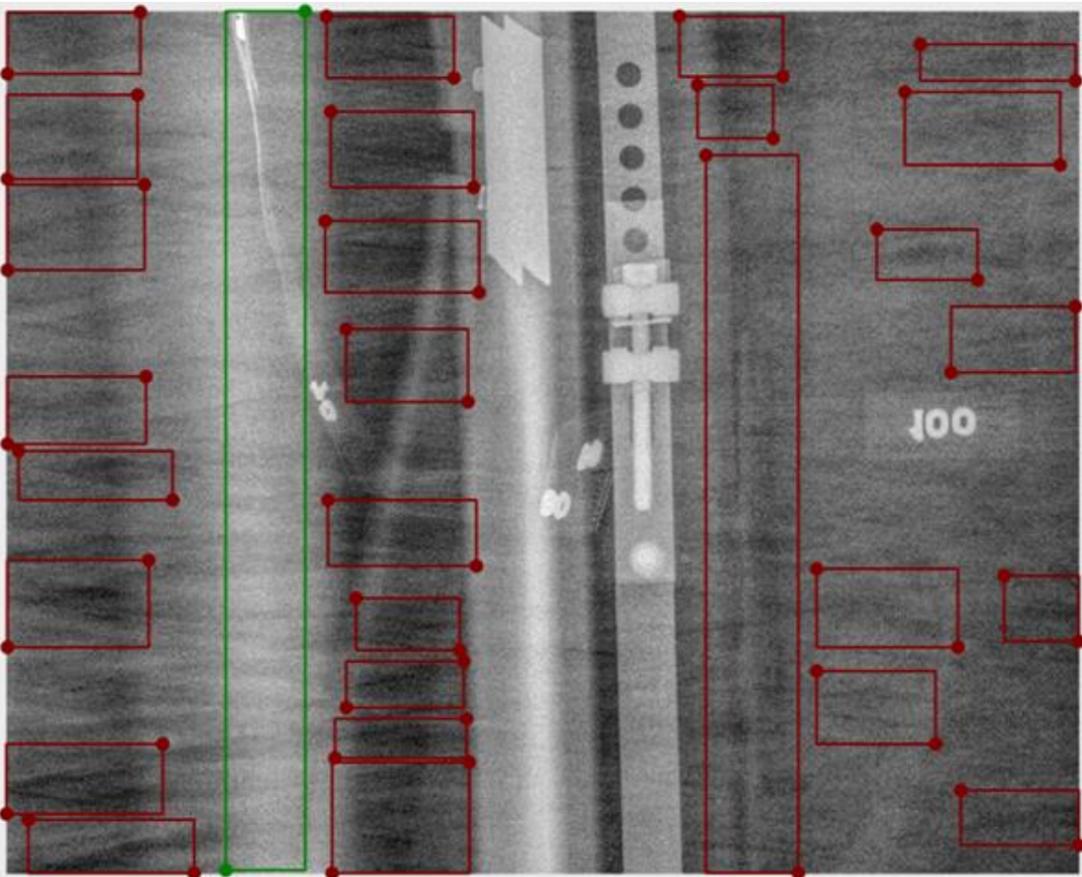


category 5

\$11 B to replace blades
\$70M lost revenue per day

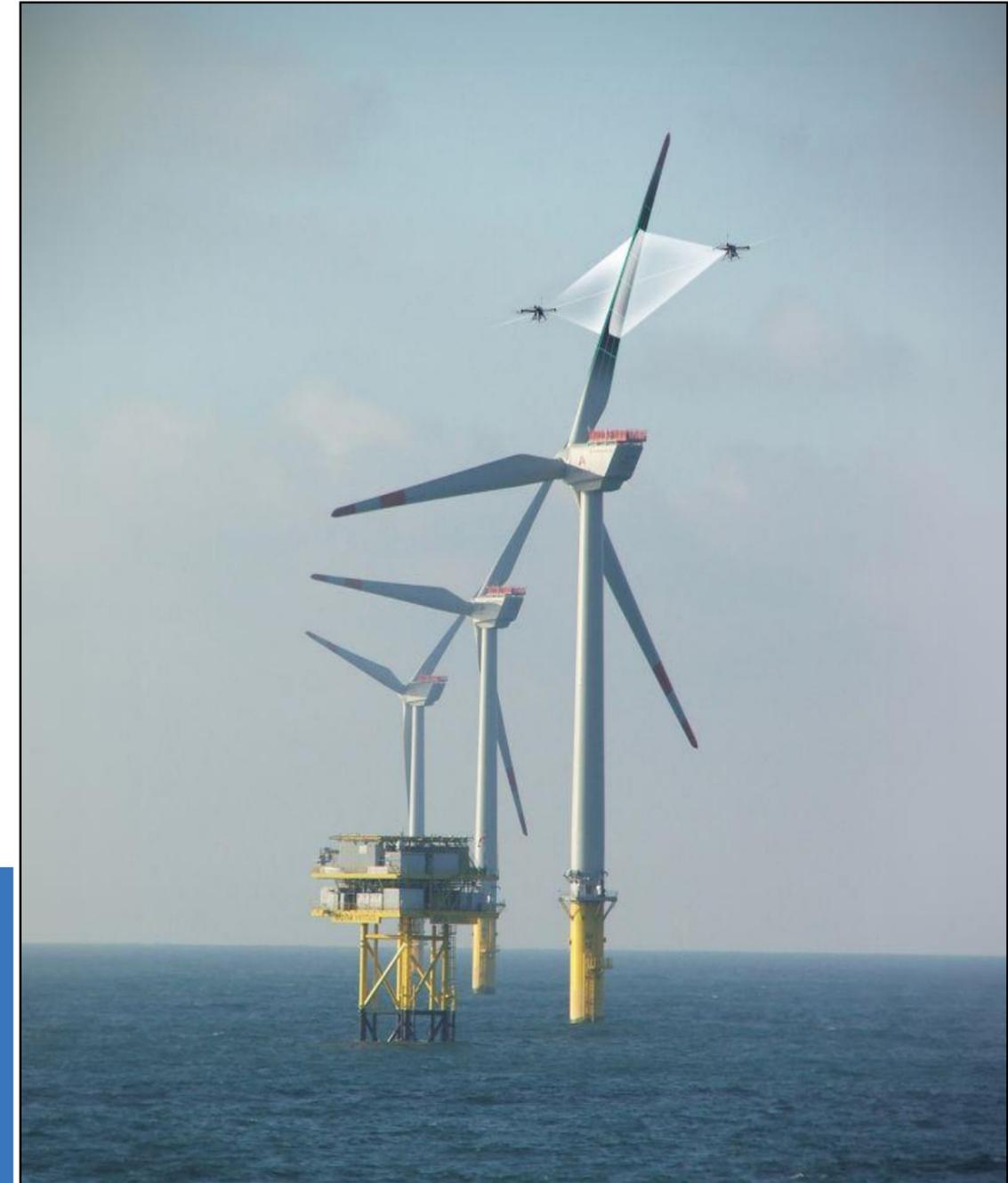
Defects we are looking into





Solution

SpectX is one complete integrated system designed to detect all internal structural defects of asset infrastructure through digital radiography & completely automate the inspection process by providing a docking system.



SpectX asset management portal

- Cloud service for asset owners or operators
- Effective predictive maintenance

1. Blade view (damage severity analysis)

Select defected areas to review the inspection results and analytics

Wind Turbine Blade
#WTGB 413

Defect Info:

Serial No	K1368
Damage	Diagonal crack & Air void
Size	12 cm X 20 cm x 7 mm 2 cm X 2 cm x 3.5 cm
Severity level	8
Possible cause	Manufacturing defect
Location	X = 46.2m Y=4.3m Z=1.2m
Latest repair	21 September 2019
Latest inspection	2 December 2022

Radiographic data for selected regions

#K1368

#K1598

Defect Info:

Serial No	K1598
Damage	Major internal crack
Size	7 cm X 3 cm x 9 mm
Severity level	5
Possible cause	Delamination & operational load
Location	X= 53.7m Y=3.9m Z=0.8m
Latest repair	21 September 2019
Latest inspection	2 December 2022

2. Turbine view

Select a turbine asset to review its inspection records

Wind Turbine
#IL1256

Real Time Condition
Click on boxes to get inspection schedules

Blade A Serial No: 413	Impact
↓ 13.8%	
Blade B Serial No: 412	No damage
↑ 6.3%	
Blade C Serial No: 411	No damage
↑ 7.8%	

Inspection Schedule
December 2022

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Defect level
Based on internal radiography

Blade A Medium or intermittent defect	60%
Blade B No defects detected	29%
Blade C No defects detected	18%

3. Windfarm view

Select wind farm and wind turbine to review its spec

Wind Farm
WF 3TG678 (Borssele)

Select the view: E21 front view

Inspection Reports

- #IL256: Major cracks and air void defect detected on blade A - Priority 3 - crack
- #IL585: No major internal defects detected
- #IL3786: No major internal defects detected
- #IL8417: Delamination at left spar cap - shear web detected on Blade C - Priority 4
- #IT5781: Delamination on Blade C - Priority 7 - reduction in blade load bearing capacity and possibly near surface buckling
- #IR1766: Minor issues. Rest of inspection scheduled.
- #IL1856: No major internal defects detected

Inspection Frequency for #IL1256

WTG Info:

Serial No:	#IL1256	Model:	SG 10.0-193 DD
Rating:	10 MW	Manufacturer:	Siemens
Diameter:	193m	Latitude:	51°42'25.2"N
Height:	125m	Longitude:	2°54'44.6"E

[Inspection Analysis](#)

Dual-drone aerial radiography system

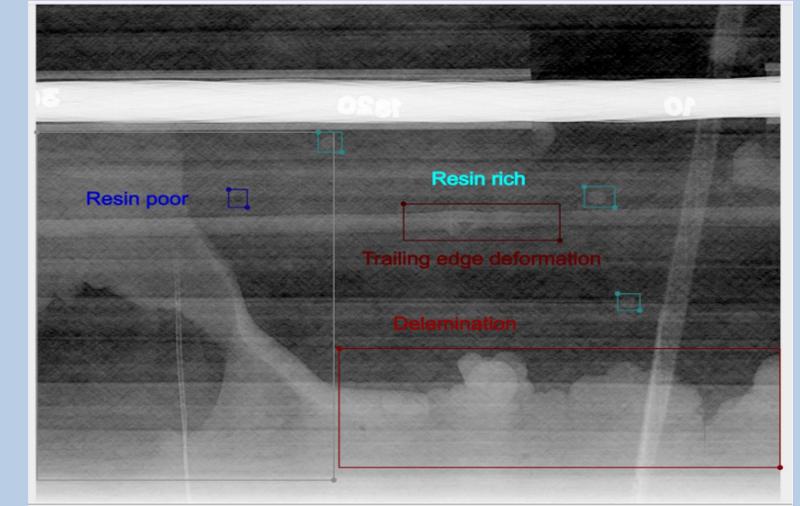
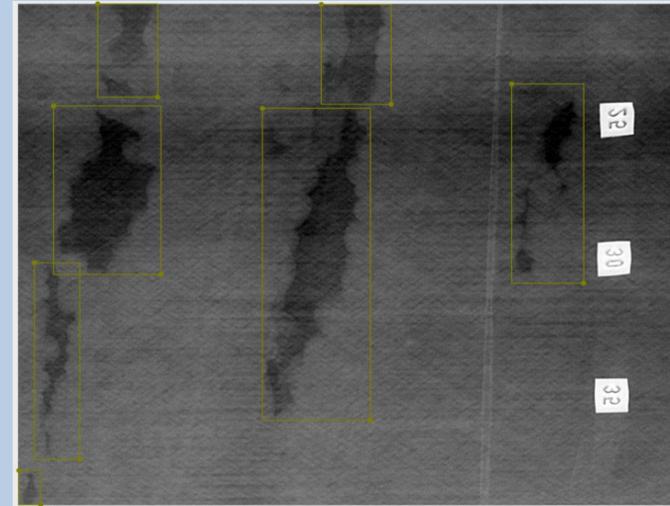


Technical Challenges

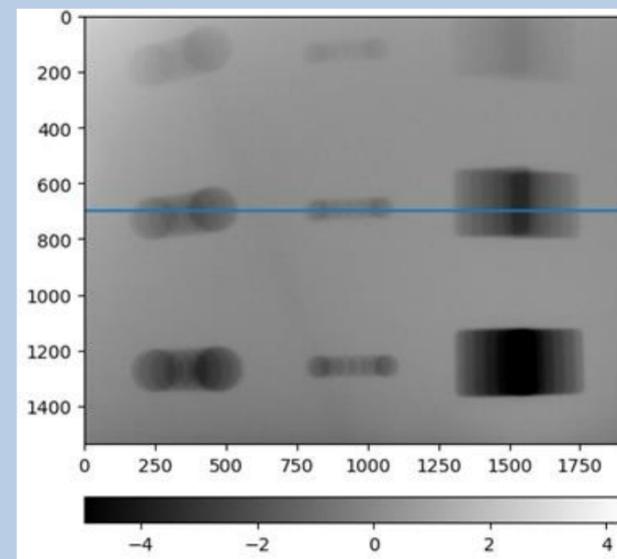
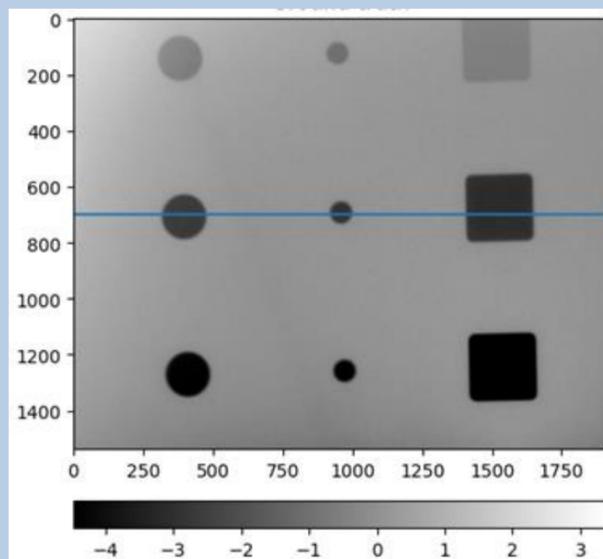
Heavy payload

- 6 kg X-ray source
- Stabilization mechanism
- Flight time

Automatic defect detection



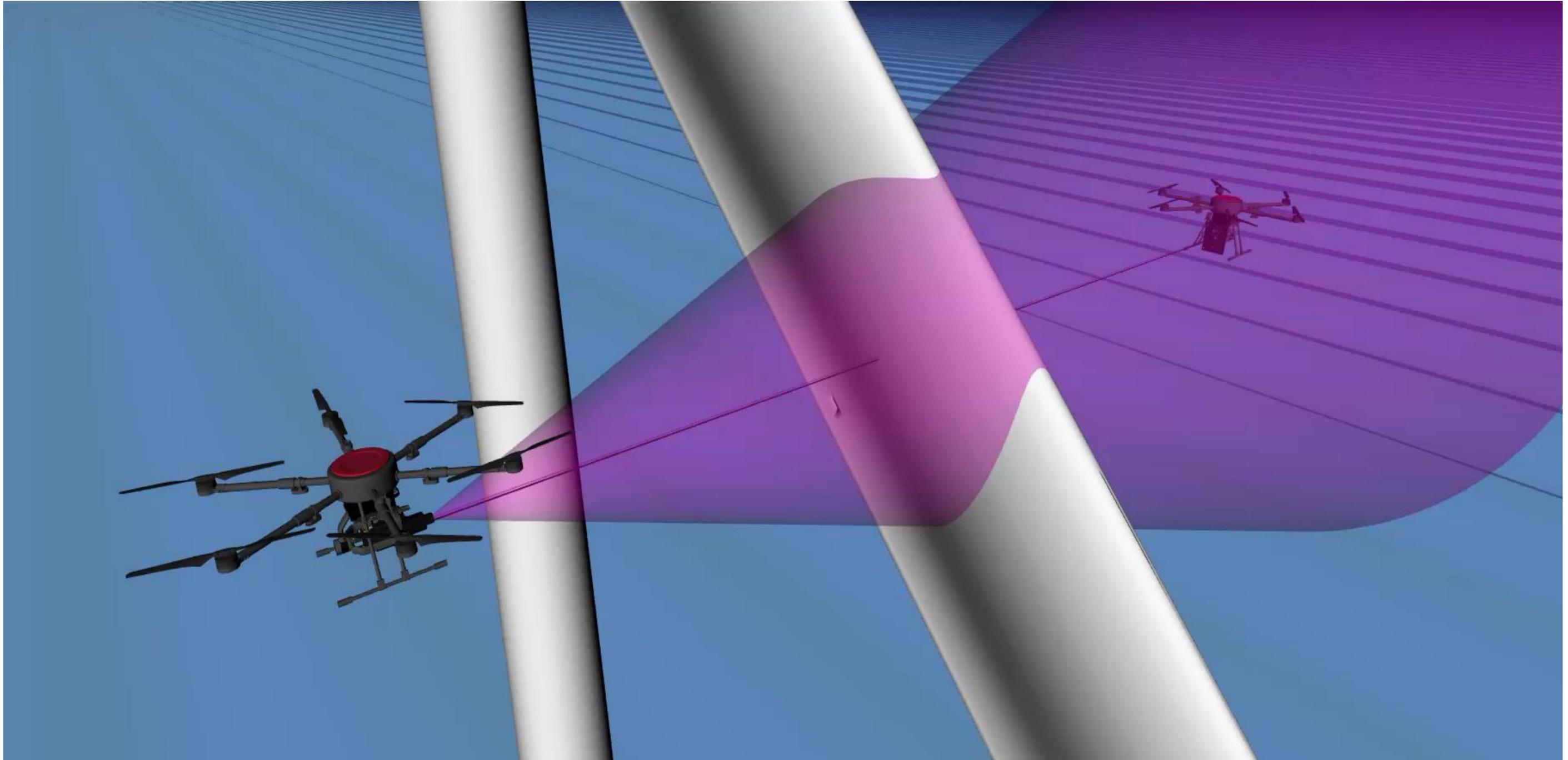
Motion blur



Alignment of X-ray source and detector



Gimbal alignment





SPECTX

TU/e



Avular

Realization



Proof of concept



Proof of concept

First X-Ray images collected in-flight

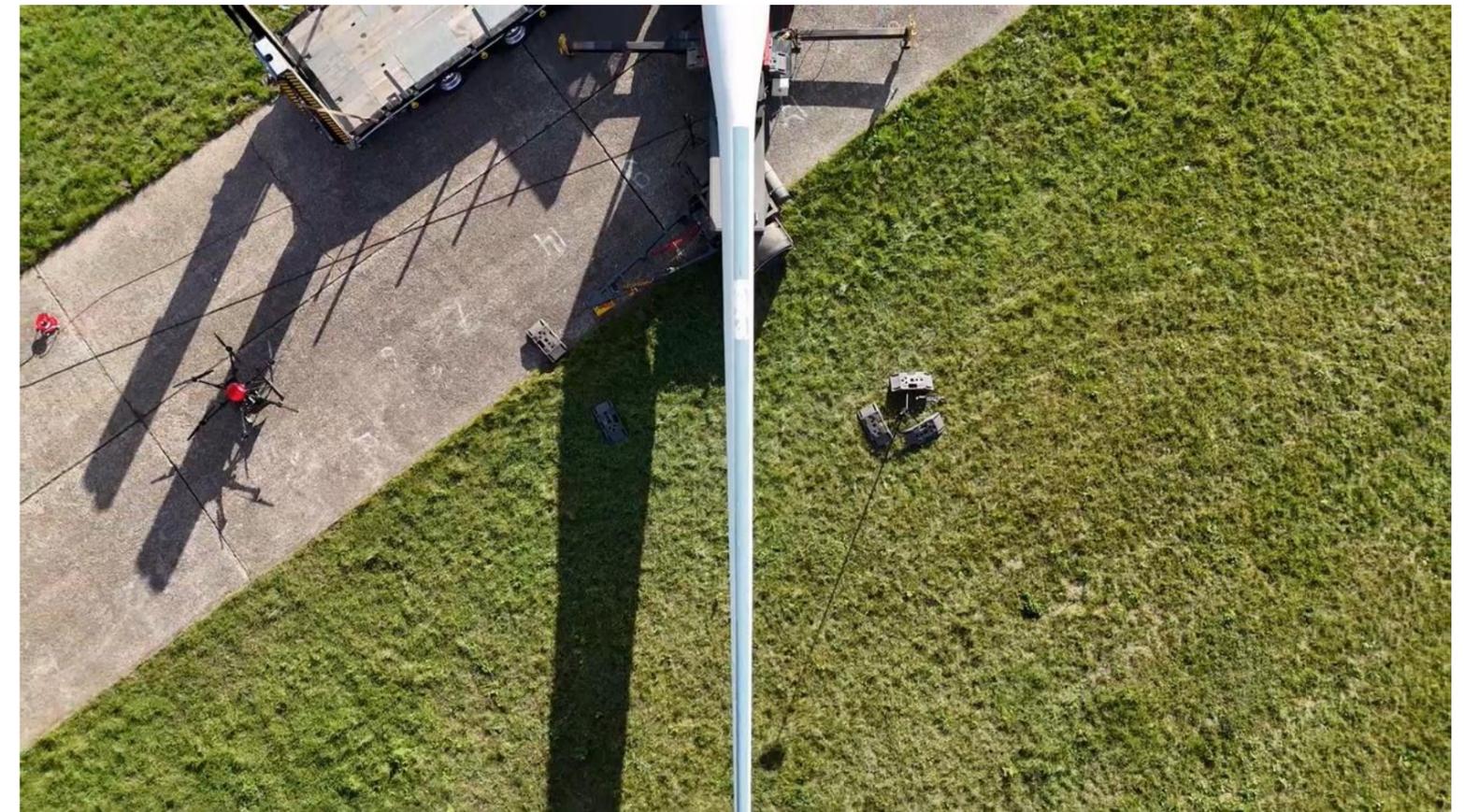
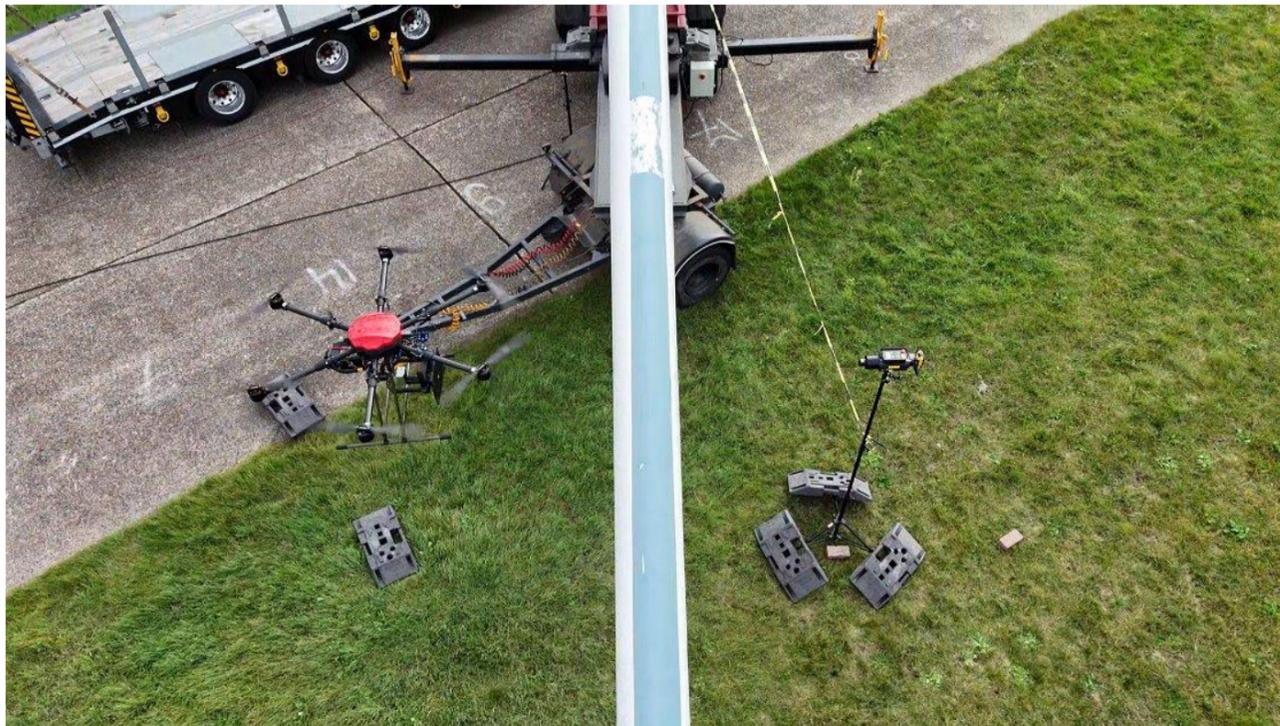
📅 5th November

📍 Vlissingen, de KAAP innovationpoint



Proof of concept

Test 1: Static source, Flight with detector



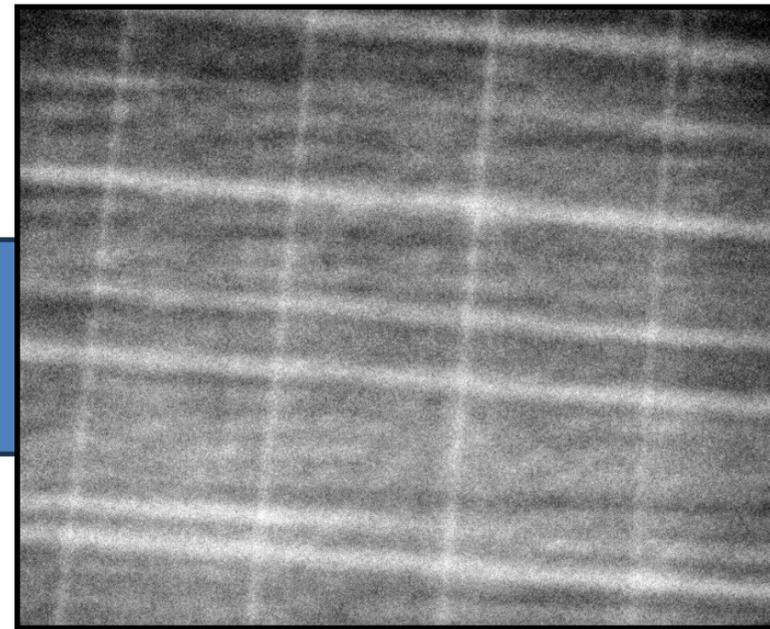
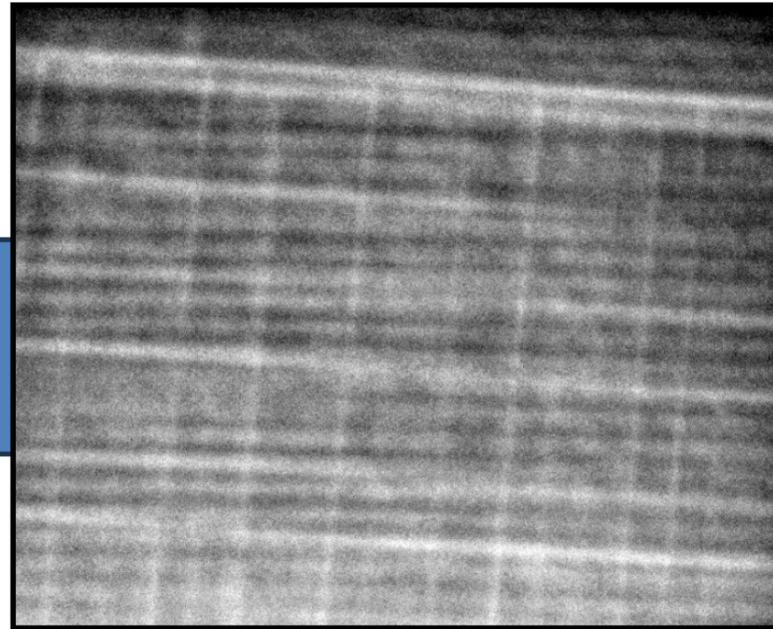
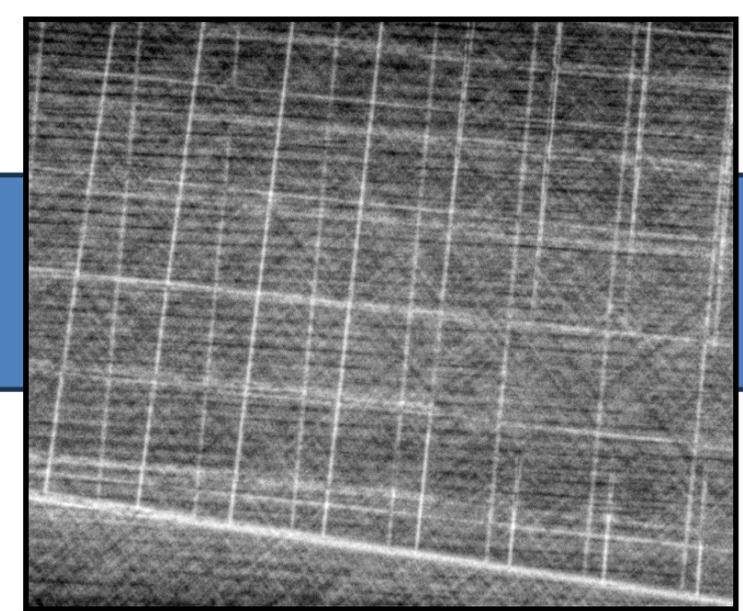
Proof of concept

Test 2: Static detector, Flight with source

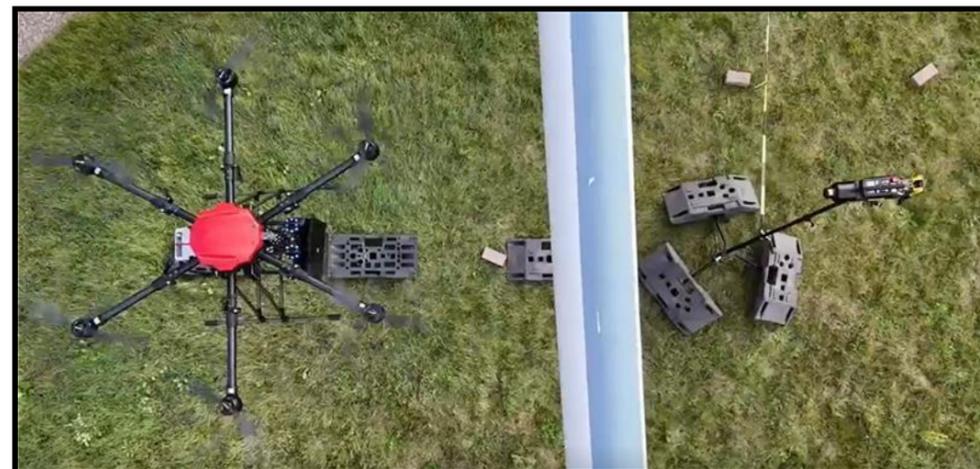


Proof of concept

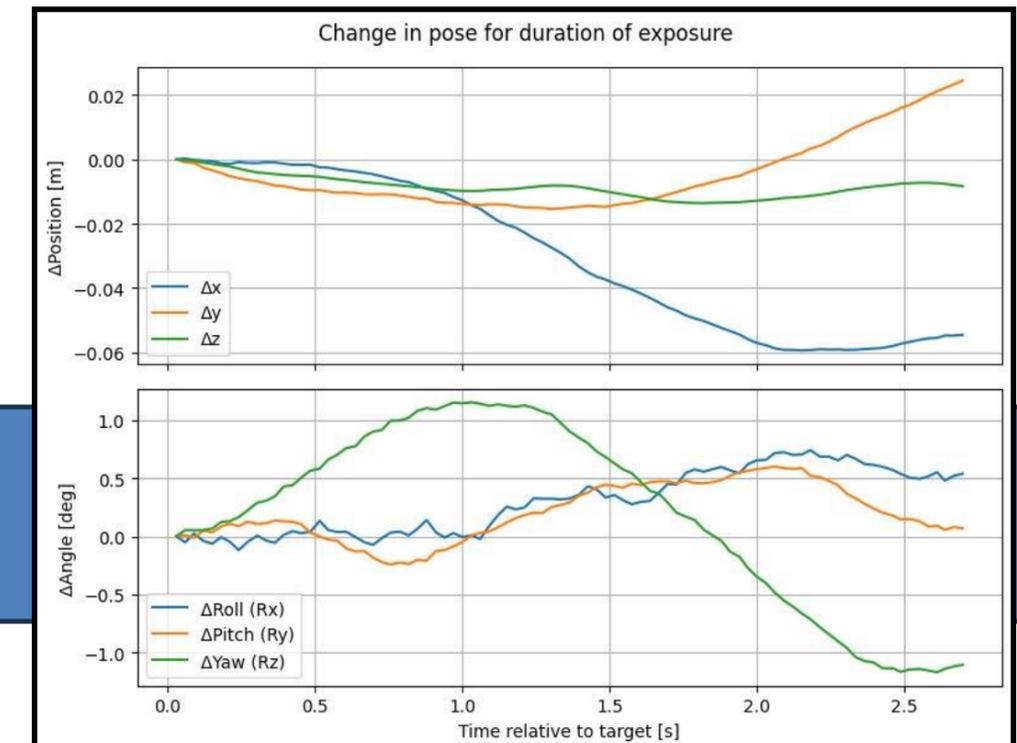
Static X-Ray image
of wind turbine blade



X-Ray images of wind turbine blade
taken with one drone



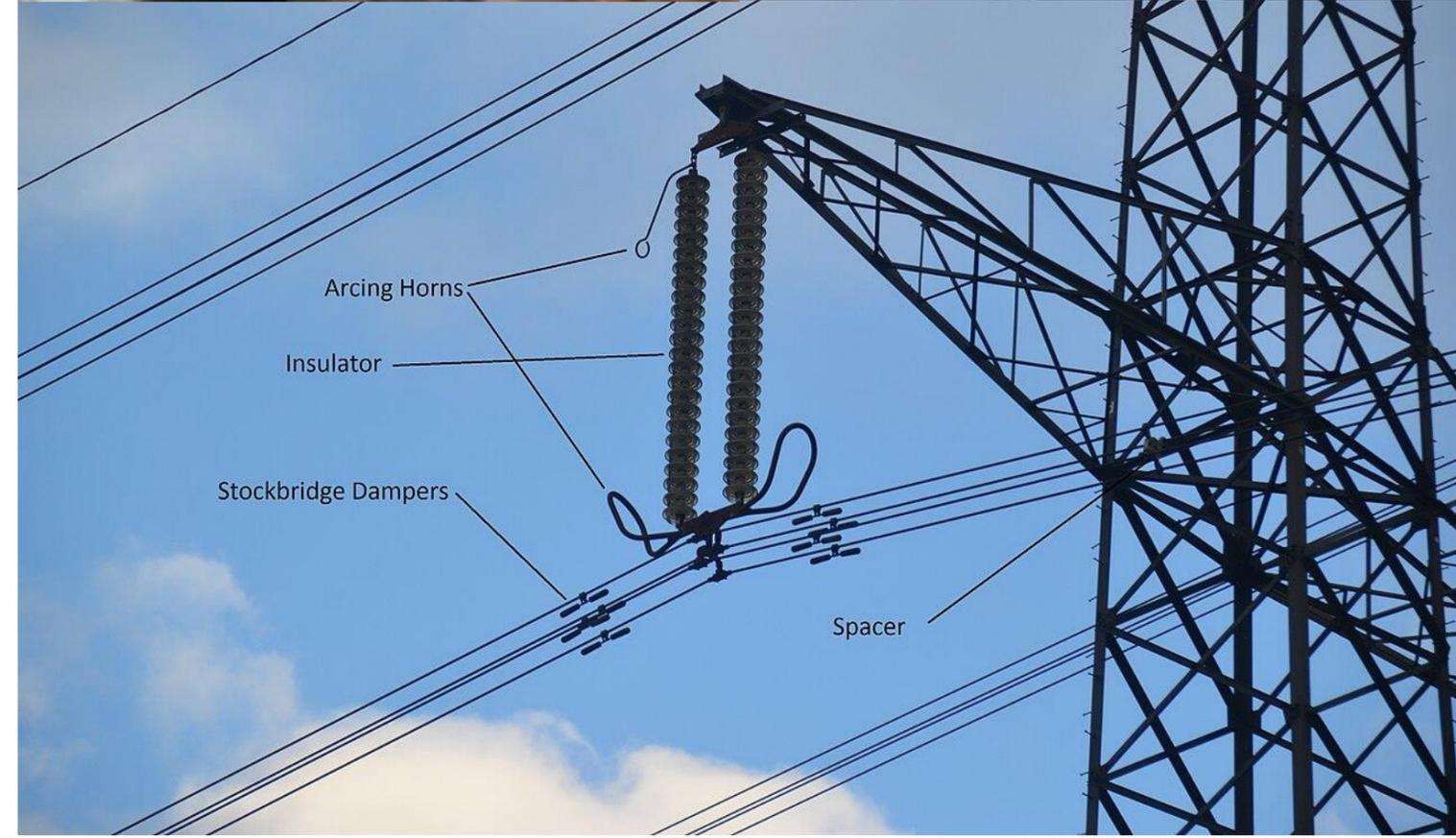
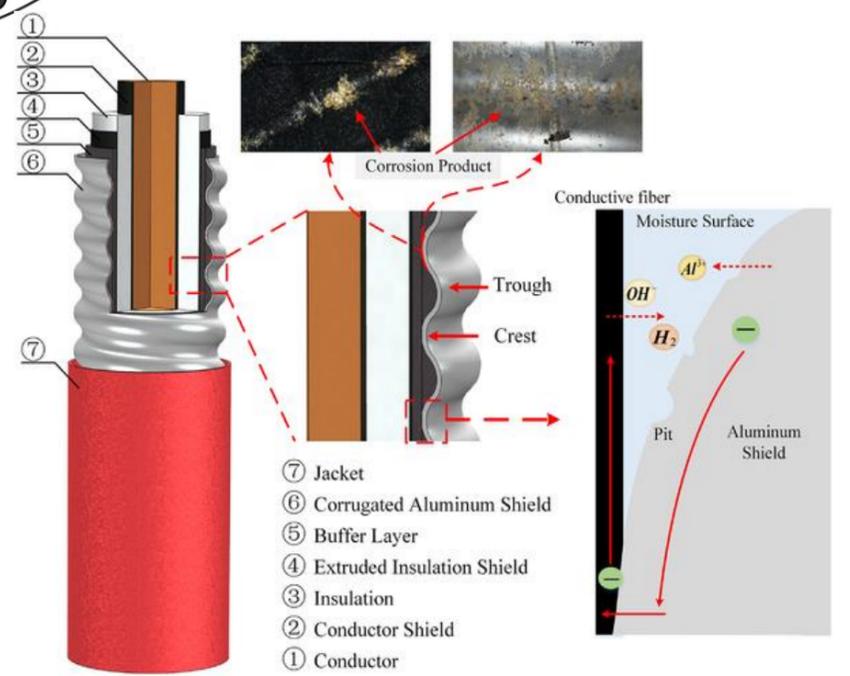
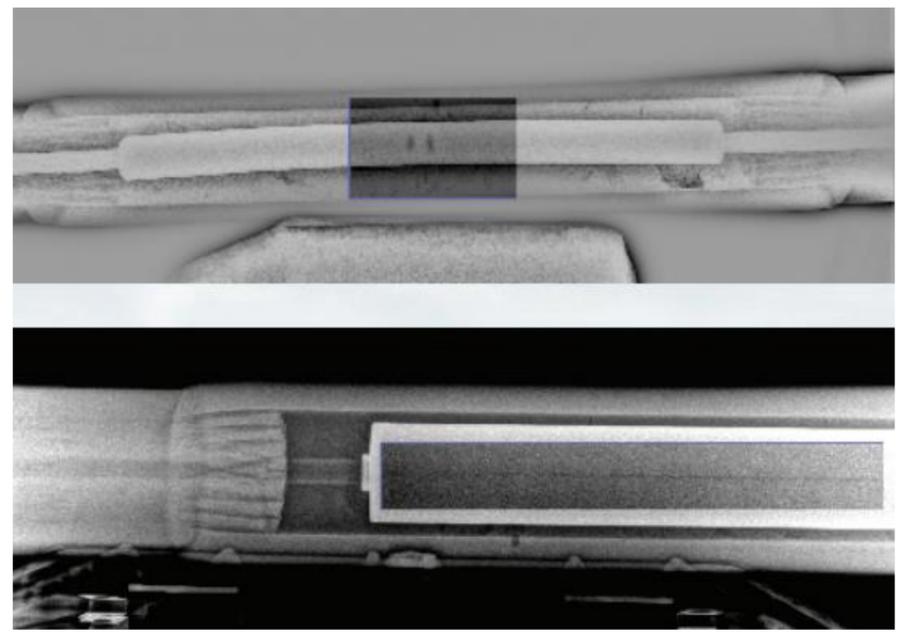
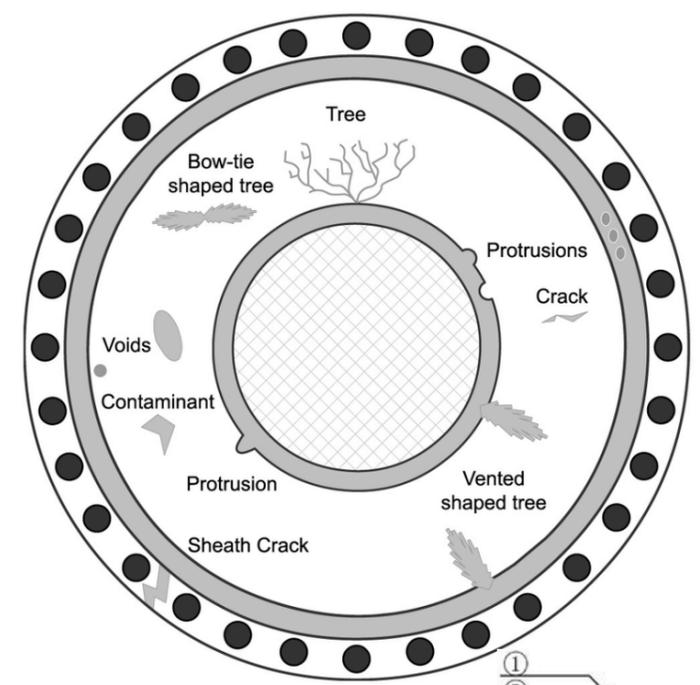
Leveraging motion data
for deblurring



Gimbal alignment tests



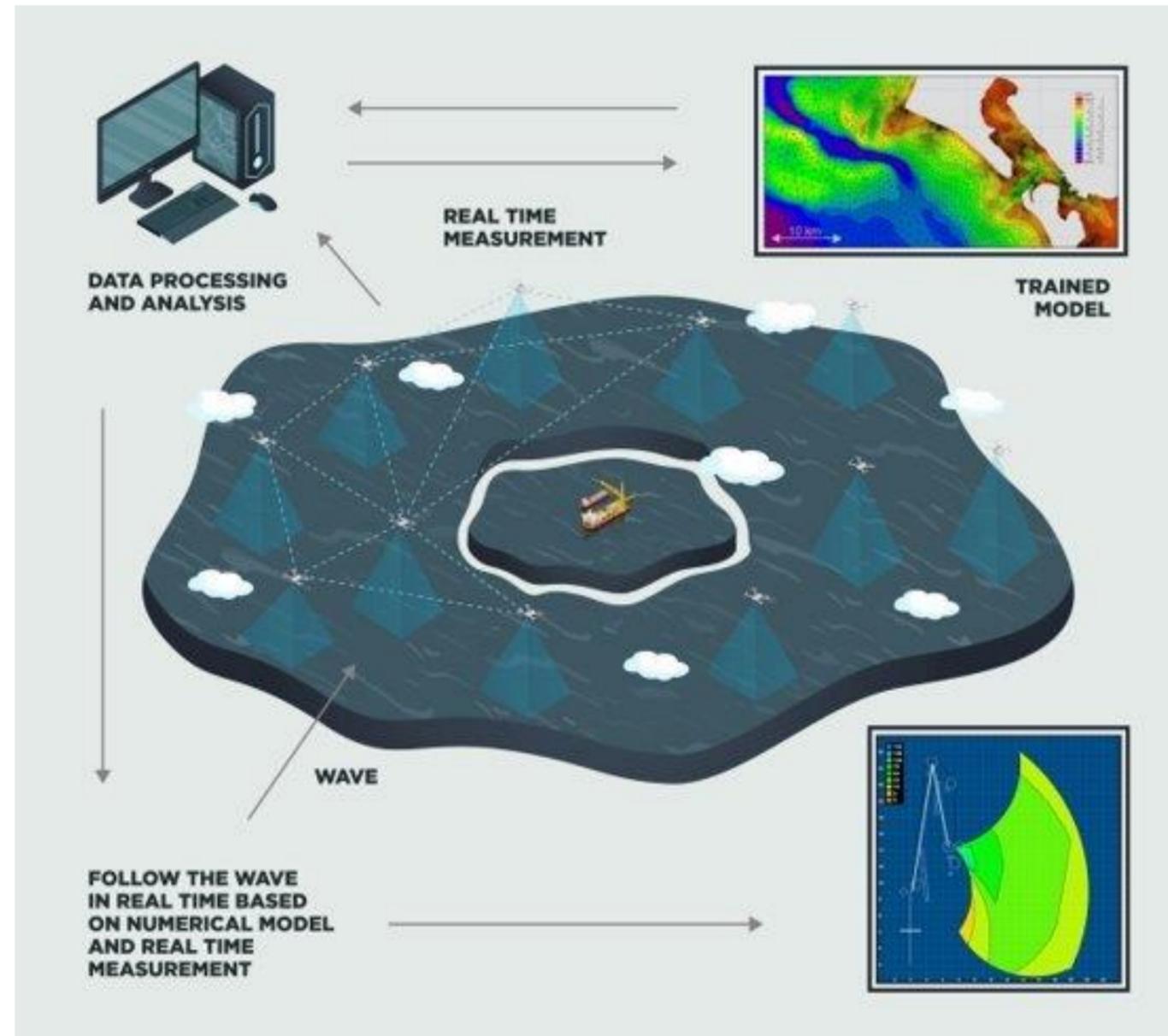
Problems within the Power line Industry



Use case: Power Grid Lines



Drones for offshore monitoring: Aquafind



Questions?



**Stay tuned
for takeoff!**



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